

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) Publication number:

0 597 388 A2

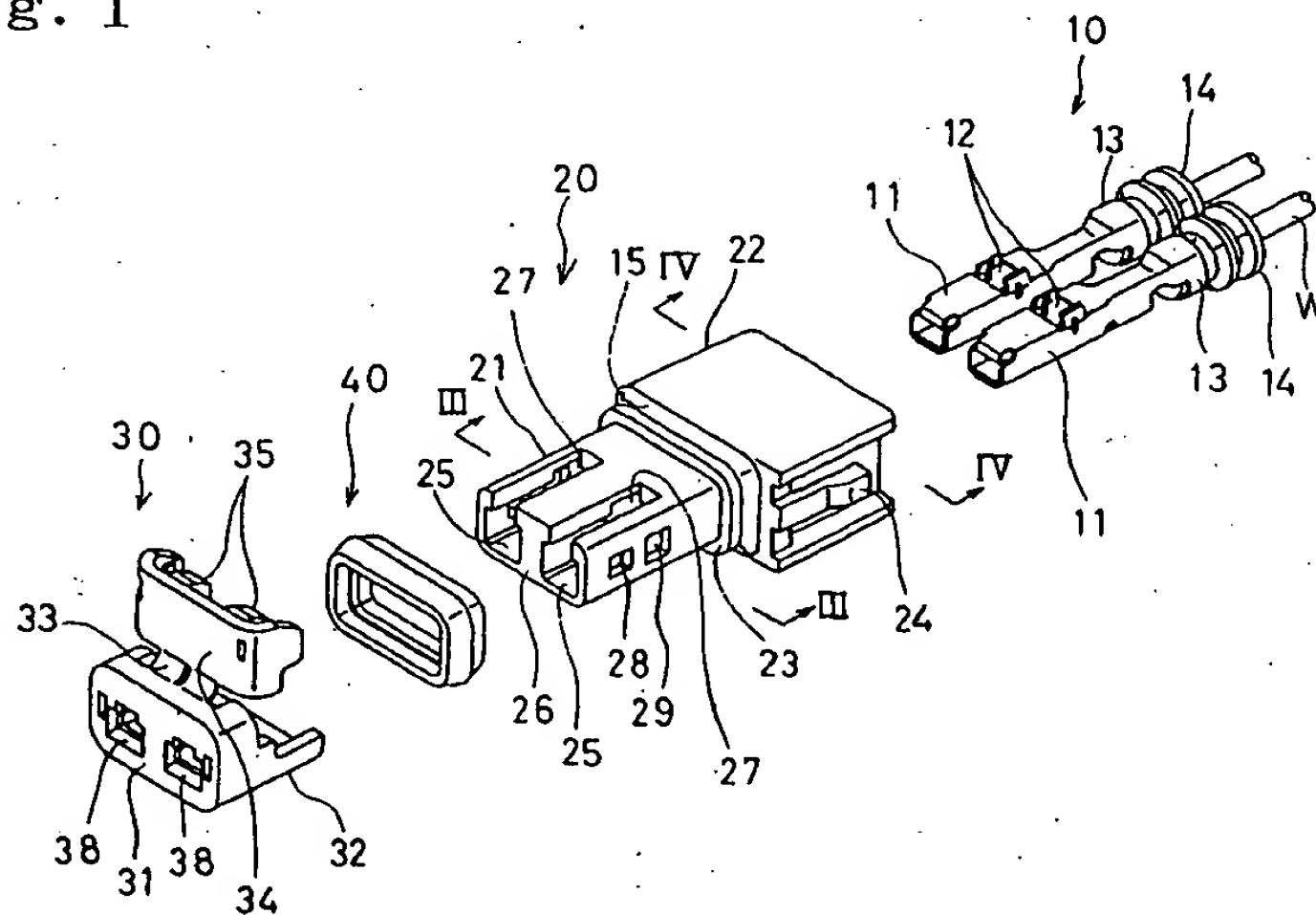
(12)

EUROPEAN PATENT APPLICATION(21) Application number: **93117894.1**(51) Int. Cl.⁵: **H01R 13/52**(22) Date of filing: **04.11.93**(30) Priority: **11.11.92 JP 84217/92**(43) Date of publication of application:
18.05.94 Bulletin 94/20(84) Designated Contracting States:
DE GB(71) Applicant: **Sumitomo Wiring Systems, Ltd.**
1-14, Nishisuehiro-cho
Yokkaichi-shi Mie-ken(JP)(72) Inventor: **Tanaka, Tsutomu**
1-14, Nishisuehiro-cho, Yokkaichi-shi,
Mie-ken,(JP)(74) Representative: **KUHLEN, WACKER &**
PARTNER
Alois-Steinecker-Strasse 22
D-85354 Freising (DE)(54) **Waterproof electrical connector.**

(57) A waterproof electrical connector includes a housing (20) inserted into a cavity (50) defined in a counterpart of the connector and having a stepped portion (23) in its rear portion such that an enlarged portion (22) is provided by the stepped portion (23), an annular sealing member (40) fitted with the housing (20) through a front portion thereof relative to the direction in which the housing (20) is inserted into the cavity (50) of the counterpart, to abut the

stepped portion (23) for sealing a gap between the housing (20) and an inner peripheral wall surface of the cavity (50), and an engagement member (30) engaging an outer periphery of the housing (20) at a position where it abuts one end of the sealing member (40), in a condition that the sealing member (40) is fitted with the housing (20) to abut the stepped portion (23), thereby providing another enlarged portion.

Fig. 1



This invention relates to a waterproof electrical connector electrically interconnecting electrical circuits or equipment in a severe environmental condition such as in an engine room of an automobile vehicle.

FIG. 10 illustrates one of conventional waterproof connectors. A housing 1 of the connector comprises a sleeve 4 having a terminal aperture 3 into which a female terminal member 2 is inserted, and a hood 5 surrounding the sleeve 4. A connector seal 6 is closely attached to an outer periphery of the sleeve 4 between the sleeve 4 and the hood 5.

An upper interior of the sleeve 4 serves as the terminal aperture 3. An elastic engagement piece 7 is formed on the bottom of the terminal aperture 3 and an engagement protrusion 8 is formed on a distal end of the engagement piece 7 to protrude into the terminal aperture 3.

A counterpart connector 9 to be fitted with the above-described connector is formed into a cylindrical shape so that the sleeve 4 of the connector is inserted into it and so that it is inserted into the hood 5. The connector seal 5 is compressed to be inserted between an inner peripheral face of the connector 9 and an outer peripheral face of the sleeve 4.

When the terminal member 2 is thrust into the terminal aperture 3 through its rear opening, a distal end of the terminal member 2 is engaged with the engagement protrusion 8 such that the engagement piece 7 is yielded downwards. When the terminal member 2 is inserted into the terminal aperture 3 to assume a predetermined position, the yielded engagement piece 7 returns to its former state and the engagement protrusion 8 enters an aperture formed in the underside of the terminal member 2 such that the terminal member 2 is held in position.

When the waterproof connector is connected to the counterpart connector 9, the waterproof connector is thrust into the connector 9 so that the sleeve 4 invades the cylindrical interior of the connector 9. Then, the connector seal 5 attached to the innermost of the sleeve 4 is thrust between the outer peripheral face of the sleeve 4 and the inner peripheral face of the counterpart connector 9, thereby closely adhering both of them to prevent invasion of water.

In the above-described conventional connector, the attachment of the connector seal 5 is troublesome since the connector seal 5 is attached to the innermost of the sleeve 4 surrounded by the hood 5. Furthermore, it is difficult to confirm whether the connector seal 5 assumes its normal position or not.

Furthermore, the elastic engagement piece 7 is formed on the cylindrical peripheral wall of the

terminal aperture 3 so that the terminal member 2 is held in its normal position. Consequently, the forming of the waterproof connector is difficult and it is restricted in its forming.

Therefore, an object of the present invention is to provide a waterproof electrical connector which can be formed readily and wherein the connector seal can be attached readily and reliably.

In one aspect, the present invention provides a waterproof electrical connector comprising a housing inserted into a cavity defined in a counterpart of the connector and a generally annular sealing member fitted with the housing through a front portion thereof relative to a direction in which the housing is inserted into the cavity of the counterpart, thereby sealing a gap between the housing and an inner peripheral wall surface of the cavity, characterized in that the housing has a stepped portion in a rear portion thereof relative to the direction in which the housing is inserted into the cavity of the counterpart such that an enlarged portion is provided by the stepped portion and characterized by an engagement member engaging an outer periphery of the housing at a position where the same abuts one end of the sealing member relative to the direction in which the housing is inserted into the cavity of the counterpart, in a condition that the sealing member is fitted with the housing to thereby abut the stepped portion, thereby providing another enlarged portion.

The stepped portion is formed in the rear portion of the housing such that the enlarged portion is provided by the stepped portion. When fitted with the outer periphery of the housing, the rear end of the sealing member abuts the stepped portion, which prevents further thrust of the sealing member. Subsequently, the engagement member is engaged with the outer periphery of the housing at the position where it abuts the front end of the sealing member engaged with the stepped portion. Since the engagement member is engaged with the housing outer periphery, the housing is enlarged. Accordingly, the annular sealing member is engaged both with the stepped portion and with the engagement member such that it is held therebetween to assume its normal position on the outer periphery of the housing.

According to the above-described construction, the sealing member can be reliably attached at its normal position when it is fitted with the outer periphery of the housing and the engagement member is engaged with the housing. Furthermore, the terminals can be engaged at the predetermined positions in the terminal apertures respectively.

Preferably, the housing includes a pair of terminal apertures into which a pair of terminals are inserted respectively. The terminal apertures are formed to extend through front and rear ends of the

housing relative to the direction in which the housing is inserted into the cavity of the counterpart. Each terminal aperture has an engagement aperture communicating with the outer peripheral surface of the housing. The engagement member has engagement convex portions invading the terminal apertures through the engagement apertures to thereby engage the terminals respectively. In this case, the terminals can be held in the terminal apertures in position respectively when the engagement member is engaged with the housing.

In another aspect, the invention provides a waterproof electrical connector comprising a housing having a pair of terminal apertures into which a pair of terminals are inserted respectively, the terminal apertures being formed to extend through front and rear ends of the housing relative to the direction in which the housing is inserted into a cavity of a counterpart, characterized in that each terminal aperture has an engagement aperture communicating with the outer peripheral surface of the housing and characterized by a housing cap engageable with the front end of the housing relative to the direction in which the housing is inserted into the cavity of the counterpart, thereby covering the front end, the housing cap having engagement convex portions inserted through the engagement apertures into the terminal apertures so that the engagement convex portions are engaged with terminals in the terminal apertures, respectively.

Since the connector is divided into the housing and the housing cap, these members can be simplified, which reduces the restriction in the forming and assembly.

The invention will be described, merely by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is an exploded perspective view of the waterproof electrical connector of an embodiment in accordance with the present invention;

FIG. 2 is a transversely sectional view of the connector;

FIG. 3 is a sectional view taken along line 3-3 in FIG. 1;

FIG. 4 is a sectional view taken along line 4-4 in FIG. 1;

FIG. 5 is a rear view of the housing cap employed in the connector;

FIG. 6 is a transversely sectional view of the connector with the terminal members inserted into the respective terminal apertures;

FIG. 7 is a transversely sectional view of the connector inserted in a cavity of the counterpart;

FIG. 8 is an exploded view of a modified form of the connector;

FIG. 9 is an exploded view of another modified form of the connector; and

FIG. 10 is a sectional view of a conventional waterproof electrical connector.

An embodiment of the present invention will be described with reference to FIGS. 1 to 9. Referring to FIG. 1, the waterproof electrical connector of the embodiment comprises a pair of female terminal members 10, a housing 20 for enclosing the female terminal members 10, a housing cap 30 attached to a front end of the housing 20 to cover it, and a waterproofing connector seal 40 attached to the outer periphery of the housing 20.

Each female terminal member 10 has at its front end a rectangular cylindrical fitting portion 11 formed by bending the front end and an engagement aperture 12 formed in its upper peripheral face. Each female terminal member 10 further has at its rear end a crimping portion 13 where one end of an electrical wire W with which a rubber plug 14 is fitted is crimped such that the wire W is connected to the terminal member 10.

The housing 20 is formed into a rectangular solid having a rectangular section. The housing 20 is divided into a front slender body portion 21 and a rear enlarged lock portion 22. A stepped portion 23 is formed between the body portion 21 and the lock portion 22. An elastic locking piece 24 is formed on one side of the lock portion 22.

Referring now FIGS. 1 and 2, the housing 20 has two terminal apertures 25 extending lengthwisely therethrough and disposed in parallel with a dividing wall 26 provided therebetween. Each terminal aperture 25 has a square aperture portion 25a in which the front fitting portion 11 of the terminal member 10 is enclosed. Each terminal aperture 25 further has a circular aperture portion 25b in which the rear pressing portion 13 of the terminal member 10 is enclosed. The rubber plug 14 is closely attached to the circular aperture portion 25b. Each of the square and circular aperture portions 25a, 25b is open at the front and rear ends of the housing 20. Each square aperture portion 25a has an engagement aperture 27 formed by cutting out its portion from the end of the housing 20 to its upper peripheral face continuously. Two mount apertures 28 and two lock apertures 29 both communicating with the respective terminal apertures 25 are formed in the right-hand and left-hand sides of the housing 20.

The housing cap 30 is formed into the shape of a cap and is fitted with the body portion 21 of the housing 20 from its front end. The housing cap 30 comprises a lid portion 31 abutting the distal end of the body portion 21 and a cylindrical portion 32 facing the periphery of the body portion 21. An upper half portion near the open end of the cylindrical portion 32 serves as a retainer portion 34 which is opened and closed by hinge portions 33. Two engagement convex portions 35 are formed

on the inner face of the retainer portion 34 so as to assume respective positions where they face the respective engagement apertures 27. The engagement convex portions 35 invade the terminal apertures 25 to engage the engagement apertures 12 of the terminal members 10 respectively. Two attachment pieces 36 are also formed on the inner face of the retainer portion 34 so as to assume respective positions where they face the respective lock apertures 29 of the body portion 21. The attachment pieces 36 invade the respective lock apertures 29 to be engaged therewith. Two engagement protrusions 37 are formed on the inner peripheral face of the cylindrical portion 32 so as to assume respective positions where they face the respective mount apertures 28 of the body portion 21. The engagement protrusions 37 invade the respective mount apertures 28 to be engaged therewith. The lid portion 31 has two windows 38 through which male terminals (not shown) are inserted into the terminal apertures 25 respectively.

The connector seal 40 is formed into an annular shape and has an inner diameter determined so that it is closely attached to the outer periphery of the body portion 21. A middle portion of the connector seal 40 has a thickness larger than its front and rear open ends. The length of the connector seal 40 is determined so as to be approximately equal to the length from the end of the cylindrical portion 32 of the housing 30 to the stepped portion 23 when the housing cap 30 is attached to the body portion 21 of the housing 20.

A counterpart member to which the above-described connector is connected has a cavity 50 into which the housing 20 to which the housing cap 30 and the connector seal 40 are attached is inserted. An inner peripheral wall of the cavity 50 continuously extends in the direction of its depth from its opening 52. A pair of male terminal members 53 projects from a rear wall of the cavity 50 toward its opening.

The operation of the waterproof electrical connector will be described. In assembling the above-described connector, the body portion 21 of the housing 20 is fitted into the annular connector seal 40 from its front end and then, thrust until the rear end face of the connector seal 40 abuts the stepped portion 23. The body portion 21 is then inserted into the cylindrical portion 32 of the housing cap 30. When the body portion 21 is inserted such that its distal end abuts the inner face of the lid portion 31 of the housing cap 30, the engagement protrusions 37 formed on the inner peripheral surface of the cylindrical portion 32 invade the mount apertures 28 formed in the body portion 21 to be engaged therein, respectively, thereby holding the housing cap 30 in position. The end face of the housing cap 30 abuts the front end

face of the connector seal 40 when the housing cap 30 is held in position, so that the connector seal 40 is held between the stepped portion 22 and the end face of the cylindrical portion 32 around the body portion 21. In this while, the retainer 34 is held in a raised state by means of the hinge portion 33, as shown in FIG. 6.

The distal ends of the wire W to which the rubber plug 14 is attached are crimped on the crimping portions 13 of the terminal members 10 respectively. Then, the terminal members 10 are inserted into the terminal apertures 25 from the side of the fitting portions 11 with engagement apertures 12 directed upwards, respectively. When the terminal members 10 are inserted deep into the respective terminal apertures 25, the hinge portion 33 is bent so that the retainer portion 34 is thrust toward the body portion 21. Then, the engagement convex portions 35 of the retainer 34 invade the engagement apertures 12 of the terminal members 10 through the engagement apertures 27 to be engaged with the terminal members 10, respectively. The attachment pieces 36 formed on the inner peripheral face of the retainer 34 invade the respective lock apertures 29 of the body portion 21 when the retainer portion 34 is fully bent, so that the retainer 34 is incorporated with the cylindrical portion 32 so as to be held closed.

The waterproof connector assembled as described above is inserted through the opening 52 into the cavity 50 of the counterpart member from the side of its housing cap 30. The connector seal 40 held around the body portion 21 is held between the outer face of the body portion 21 and the inner face of the inner wall 51, thereby sealing a gap therebetween. Male terminal members 53 of the counterpart member invade the terminal apertures 25 through the windows 38 of the housing cap 30 and are further fitted into the fitting portions 11 of the female terminal members 10, respectively, thereby being connected to the same, as shown in FIG. 7.

According to the above-described connector, the work for attaching the annular connector seal to the housing body portion 21 can be simplified since the body portion 21 is exposed outwards. Subsequently, the housing cap 30 is engaged with the body portion 21 such that the connector seal 40 is held between the stepped portion 22 and the end face of the cylindrical portion 32. Consequently, the fallout of the connector seal during transfer of the connector and failure in the mounting of the connector seal can be prevented. Furthermore, should the failure in the mounting of the connector seal occur, the failure can be visually found easily since the connector seal is attached around the housing 20 and accordingly, the connector seal is reattached with ease.

FIG. 8 illustrates a modified form of the waterproof connector. In the foregoing embodiment, a part of the cylindrical portion 32 of the housing cap 30 is opened and closed. The engagement protrusions 35 advance into and retreat out of the terminal apertures respectively in association with the part of the cylindrical portion 32 opened and closed. In the modified form, notches are formed to extend from the open end of the cylindrical portion 132 of the housing cap 130 toward the lid portion 131, whereby two elastic lance pieces 134 are provided to be opposite the engagement apertures 127 of the housing 120 respectively. The engagement protrusions 135 are formed on the inner faces of the lance pieces 134 respectively. Each engagement protrusion 135 is perpendicular at the side of the depth and inclined at the side of the open end.

According to the above-described construction, the housing 120 is inserted from the distal end of the body portion 121 into the cylindrical portion 132 of the housing cap 130 after connector seal 140 has been attached around the body portion 121 of the housing 120. In this case, the engagement protrusions 135 of the lance pieces 134 are inserted along the respective engagement apertures 127 each extending to the distal end of the body portion 121. The terminal members 110 are inserted into the respective terminal apertures 125 when the engagement protrusions 135 has been inserted such that the engagement protrusions 137 has been engaged in the mount apertures 128 of the body portion 121 respectively. The distal ends of the terminal members 110 abut the engagement protrusions 137 in the terminal apertures 125 as the terminal members 110 are inserted into the terminal apertures 125, respectively. However, since the terminal members 110 abut the inclined faces of the engagement protrusions 137 respectively, the terminal members 110 are inserted into the respective terminal apertures 125 such that the lance pieces 134 are elastically deformed to be extruded from the respective terminal apertures 125. The engagement protrusions 137 are opposite to the respective engagement apertures 112 when the terminal members 110 has been inserted to assume the normal positions. The lance pieces 134 act to return to the former shape such that the engagement protrusions 137 engages the respective engagement apertures 112. Each terminal member 110 can be prevented from falling out since the perpendicular face of each engagement protrusion 137 abuts the edge portion of the engagement aperture 112.

FIG. 9 illustrates another modified form. In the above-described modified form, the housing cap 130 provided with the lance pieces 134 includes the cylindrical portion 132 and the lid portion 131 closing one end of the cylindrical portion 132. In

the modified form shown in FIG. 9, an engagement ring 230 serving as the engagement member includes only the cylindrical portion 232. The opening of the square aperture 225a of each terminal aperture 225 is reduced so as to have the same configuration as each window 138 of the housing cap 130.

In the above-described construction, the body portion 221 fitted into the engagement ring 230 after the connector seal 240 is attached around the body portion 222 of the housing 220. The connector seal 240 is then held between the stepped portion 223 and the engagement ring 230 to be held around the body portion 221.

The foregoing disclosure and drawings are merely illustrative of the principles of the present invention and are not to be interpreted in a limiting sense. The only limitation is to be determined from the scope of the appended claims.

Claims

1. A waterproof electrical connector comprising a housing (20) inserted into a cavity (50) defined in a counterpart of the connector and a generally annular sealing member (40) fitted with the housing (20) through a front portion thereof relative to a direction in which the housing (20) is inserted into the cavity (50) of the counterpart, thereby sealing a gap between the housing and an inner peripheral wall surface of the cavity (50), characterized in that the housing (20) has a stepped portion (23) in a rear portion thereof relative to the direction in which the housing (20) is inserted into the cavity (50) of the counterpart such that an enlarged portion (22) is provided by the stepped portion (23) and characterized by an engagement member (30) engaging an outer periphery of the housing (20) at a position where the same abuts one end of the sealing member (40) relative to the direction in which the housing (20) is inserted into the cavity (50) of the counterpart, in a condition that the sealing member (40) is fitted with the housing (20) to thereby abut the stepped portion (23), thereby providing another enlarged portion.
2. A connector according to claim 1, characterized in that the housing (20) includes a pair of terminal apertures (25) into which a pair of terminals (10) are inserted respectively, the terminal apertures (25) being formed to extend through front and rear ends of the housing (20) relative to the direction in which the housing (20) is inserted into the cavity (50) of the counterpart, each terminal aperture (25) having an engagement aperture (27) communicating

with the outer peripheral surface of the housing (20), and that the engagement member (30) has engagement convex portions (35) invading the terminal apertures (25) through the engagement apertures (27) to thereby engage the terminals (10) respectively.

3. A connector according to claim 1, characterized in that the engagement member (30) is formed into the shape of a cap covering the front end of the housing (20) relative to the direction in which the housing (20) is inserted into the cavity (50) of the counterpart. 10
4. A connector according to claim 2, characterized in that the engagement member (30) is formed into the shape of a cap covering the front end of the housing (20) relative to the direction in which the housing (20) is inserted into the cavity (50) of the counterpart. 15 20
5. A connector according to claim 4, characterized in that the engagement convex portions (35) of the cap-shaped engagement member (30) are formed to advance into and retreat out of the engagement apertures (27) respectively. 25
6. A connector according to claim 5, characterized in that the cap-shaped engagement member (30) has cylindrical portions (32) opposite the peripheral face of the housing (20), each cylindrical portion (32) having a part (34) opened and closed by means of a hinge (33), and the engagement convex portions (35) are formed on the inner peripheral face of the engagement member (30). 30 35
7. A connector according to claim 6, characterized in that each engagement aperture (27) extends to the front end of the housing (20) relative to the direction in which the housing (20) is inserted into the cavity (50) of the counterpart. 40
8. A connector according to claim 4, characterized in that each engagement aperture (27) extends to the front end of the housing (20) relative to the direction in which the housing (20) is inserted into the cavity (50) of the counterpart and that each engagement convex portion (35) is formed on the inner periphery of a cylindrical portion (32) of the cap-shaped engagement member (30) opposed to the periphery of the housing (20) so that each engagement convex portion (35) faces the engagement aperture (27). 45 50 55

9. A connector according to claim 5, characterized in that the cap-shaped engagement member (130) has cylindrical portions (132) opposite the peripheral face of the housing (120), each cylindrical portion (132) having a notch forming an elastic piece (134) and the engagement convex portions (135) are formed on inner peripheral surfaces of the elastic pieces (134) so as to be opposed to the engagement apertures (127) respectively.
10. A connector according to claim 9, characterized in that each engagement aperture (127) extends to the front end of the housing (120) relative to the direction in which the housing (120) is inserted into the cavity of the counterpart.
11. A connector according to claim 1, characterized in that the engagement member (230) is formed into the shape of a ring inserted into the housing from the front end of housing (220) relative to the direction in which the housing (220) is inserted into the cavity of the counterpart.
12. A connector according to claim 2, wherein the engagement member (230) is formed into the shape of a ring inserted into the housing (220) from the front end of housing (220) relative to the direction in which the housing (220) is inserted into the cavity of the counterpart and the engagement convex portions (of the cap-shaped engagement member (230) are formed to advance into and retreat out of the engagement apertures respectively.
13. A waterproof electrical connector comprising a first connector having a cavity (50) with an inner peripheral wall continuous in a direction of the depth from an open end thereof and a second connector comprising a housing (20) inserted into a cavity (50) defined in a counterpart of the connector and a generally annular sealing member (40) fitted with the housing (20) through a front portion thereof relative to a direction in which the housing (20) is inserted into the cavity (50) of the counterpart, thereby sealing a gap between the housing and an inner peripheral wall surface of the cavity (50), characterized in that the housing (20) has a stepped portion (23) in a rear portion thereof relative to the direction in which the housing (20) is inserted into the cavity (50) of the counterpart such that an enlarged portion (22) is provided by the stepped portion (23) and characterized by an engagement member (30) engaging an outer periphery of

the housing (20) at a position where the same abuts one end of the sealing member (40) relative to the direction in which the housing (20) is inserted into the cavity (50) of the counterpart, in a condition that the sealing member (40) is fitted with the housing (20) to thereby abut the stepped portion (23), thereby providing another enlarged portion.

14. A waterproof electrical connector comprising a housing (20) having a pair of terminal apertures (25) into which a pair of terminals (10) are inserted respectively, the terminal apertures (25) being formed to extend through front and rear ends of the housing (20) relative to the direction in which the housing (20) is inserted into a cavity (50) of a counterpart, characterized in that each terminal aperture (25) has an engagement aperture (27) communicating with the outer peripheral surface of the housing and characterized by a housing cap (30) engageable with the front end of the housing (20) relative to the direction in which the housing (20) is inserted into the cavity (50) of the counterpart, thereby covering the front end, the housing cap (30) having engagement convex portions (35) inserted through the engagement apertures (27) into the terminal apertures (25) so that the engagement convex portions (35) are engaged with terminals (10) in the terminal apertures (25), respectively.
15. A connector according to claim 14, characterized in that the housing cap (130) has cylindrical portions (32) opposite the peripheral face of the housing (120), each cylindrical portion (132) having a part opened and closed by means of a hinge (133) and that the engagement convex portions (135) are formed on the inner peripheral face of the engagement member (130).
16. A connector according to claim 15, characterized in that each engagement aperture (127) extends to the front end of the housing (120) relative to the direction in which the housing (120) is inserted into the cavity of the counterpart.
17. A connector according to claim 16, characterized in that the housing (120) includes a body (121) projecting in the direction in which the housing (120) is inserted into the cavity of the counterpart, either openings of the respective terminal apertures (125) are formed in a distal end of the housing body (121) and that the engagement apertures (127) are open to extend from the opening of the terminal aper-

tures (125) to the sides of the housing body (121) respectively.

18. A connector according to claim 14, characterized in that the cap-shaped retainer (130) has cylindrical portions (132) opposite the peripheral face of the housing (120), each cylindrical portion (132) having a notch forming an elastic piece (134) and the engagement convex portions (135) are formed on inner peripheral surfaces of the elastic pieces (134) so as to be opposed to the engagement apertures (127) respectively.
19. A connector according to claim 18, characterized in that each engagement aperture (127) extends to the front end of the housing (120) relative to the direction in which the housing (120) is inserted into the cavity of the counterpart.
20. A connector according to claim 19, characterized in that the housing (120) includes a body (121) projecting in the direction in which the housing (120) is inserted into the cavity of the counterpart, either openings of the respective terminal apertures (125) are formed in a distal end of the housing body (121) and in that the engagement apertures (127) are open to extend from the opening of the terminal apertures (125) to the sides of the housing body (121) respectively.

Fig. 1

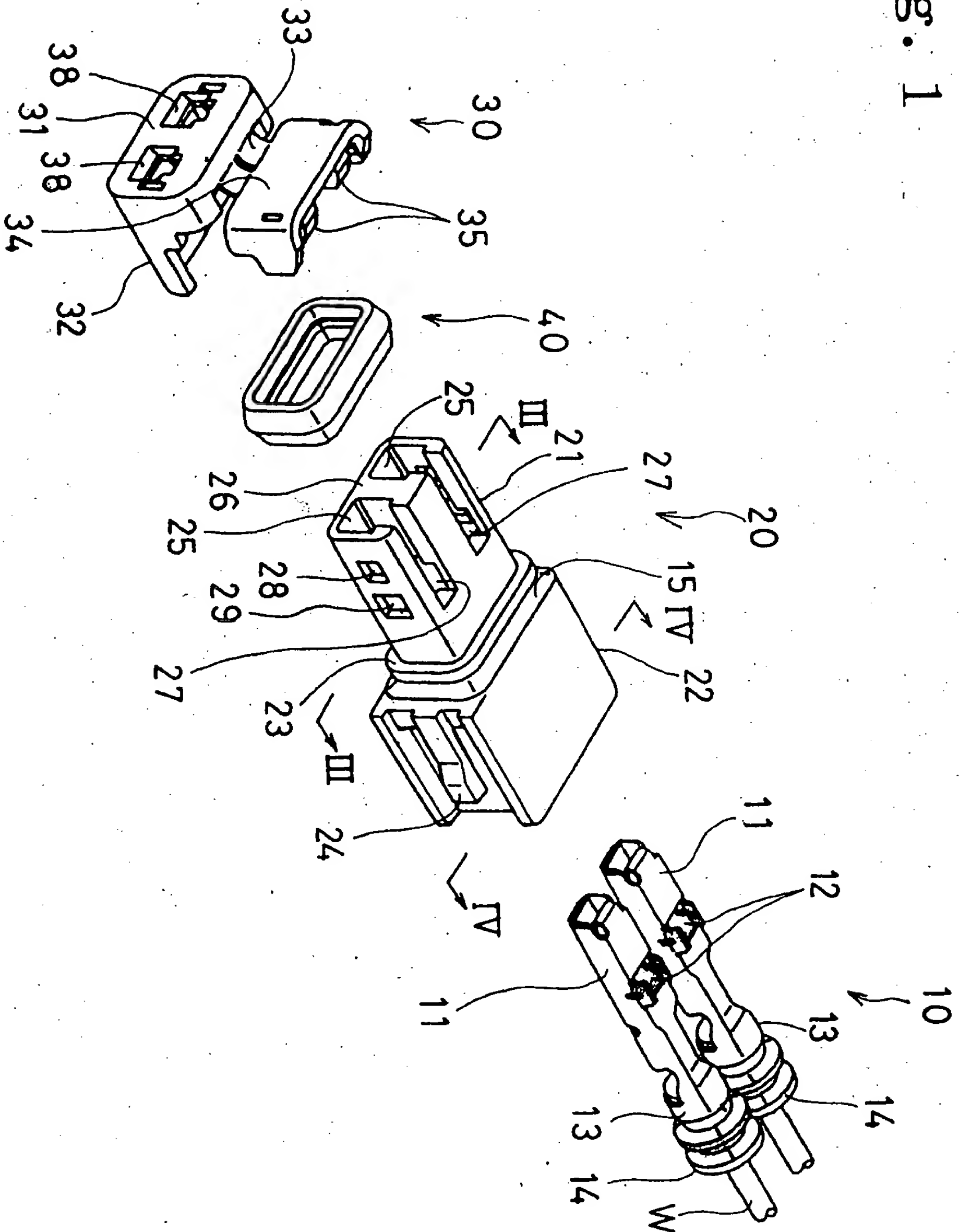


Fig. 2

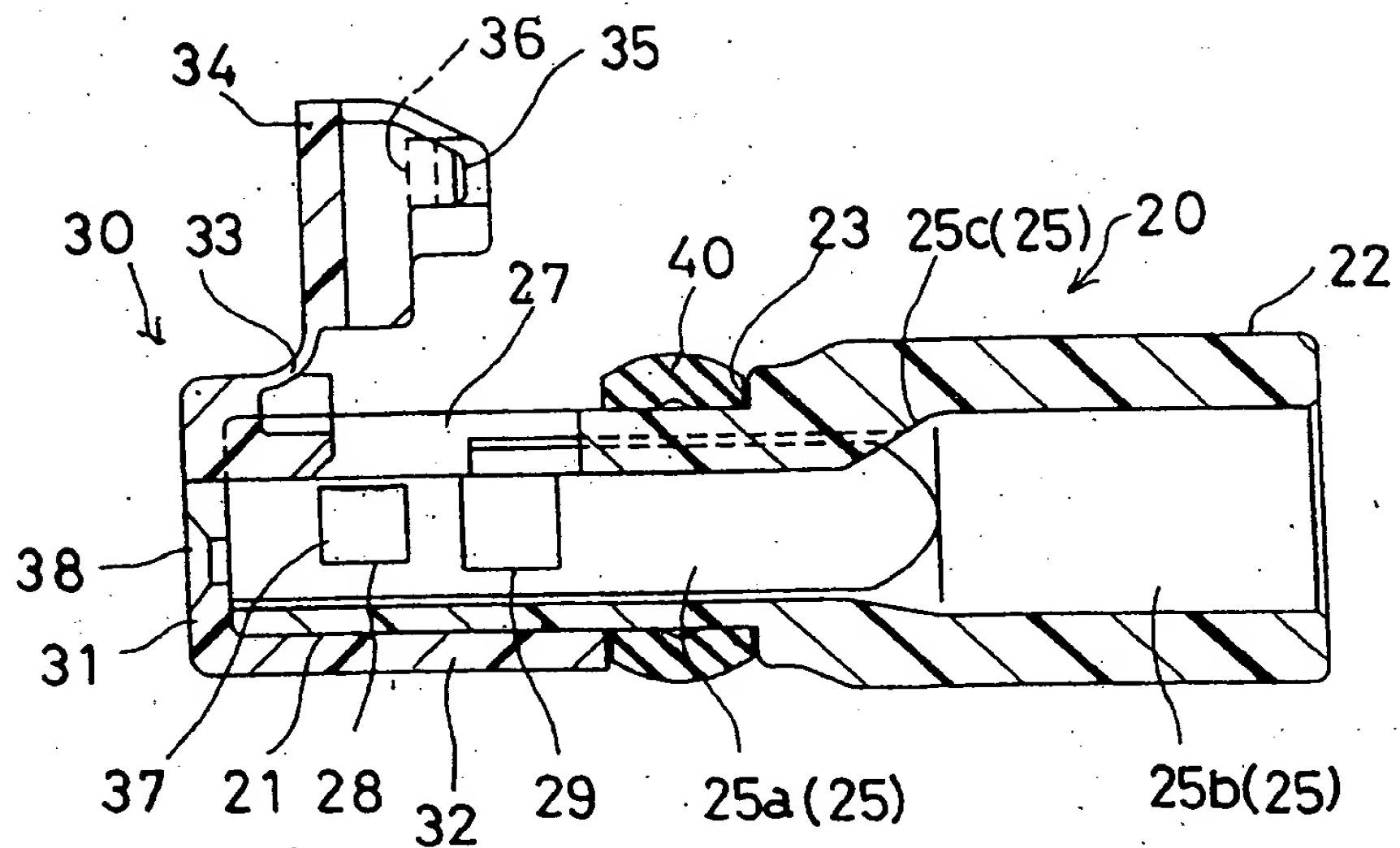


Fig. 3

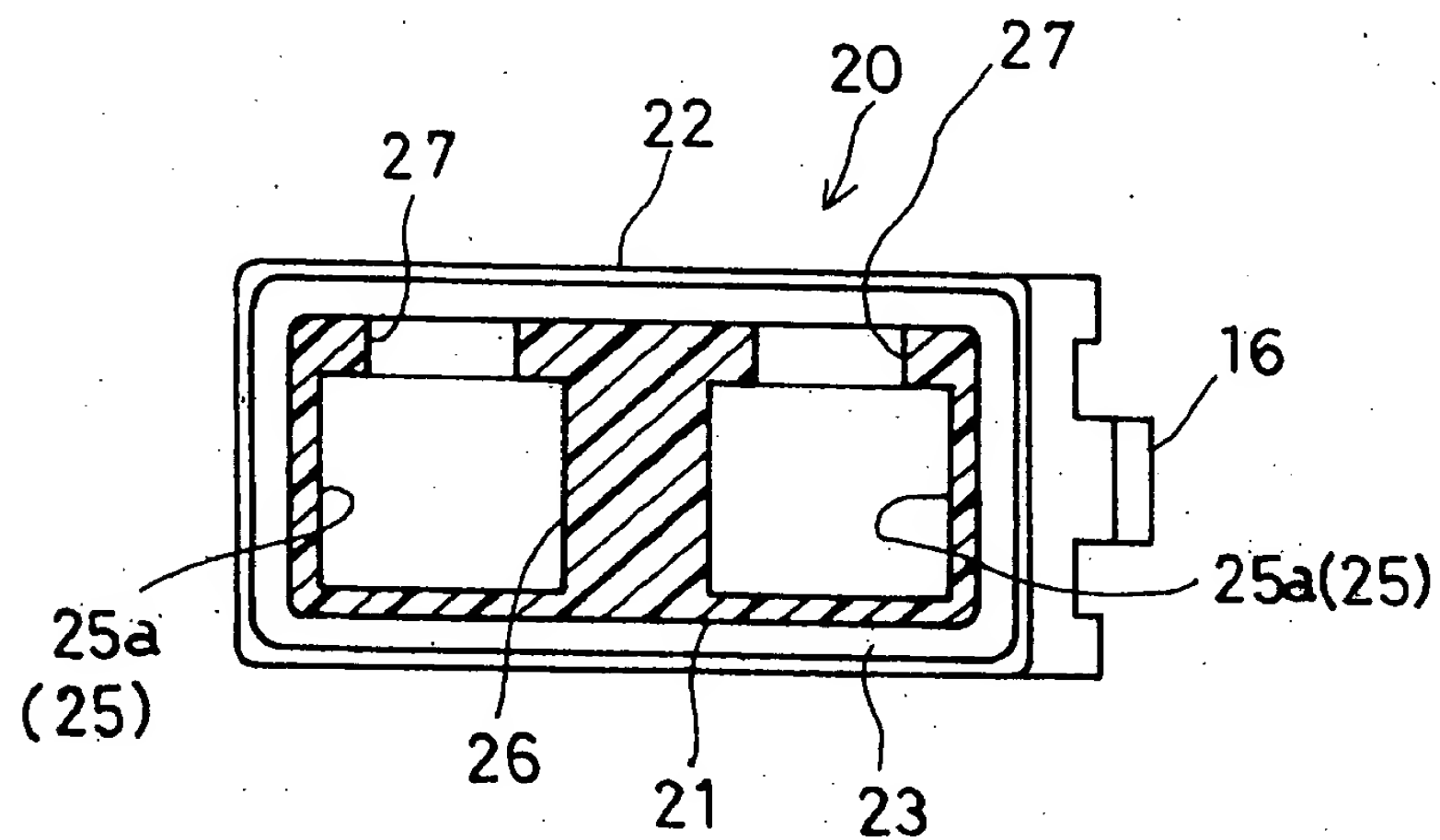


Fig. 4

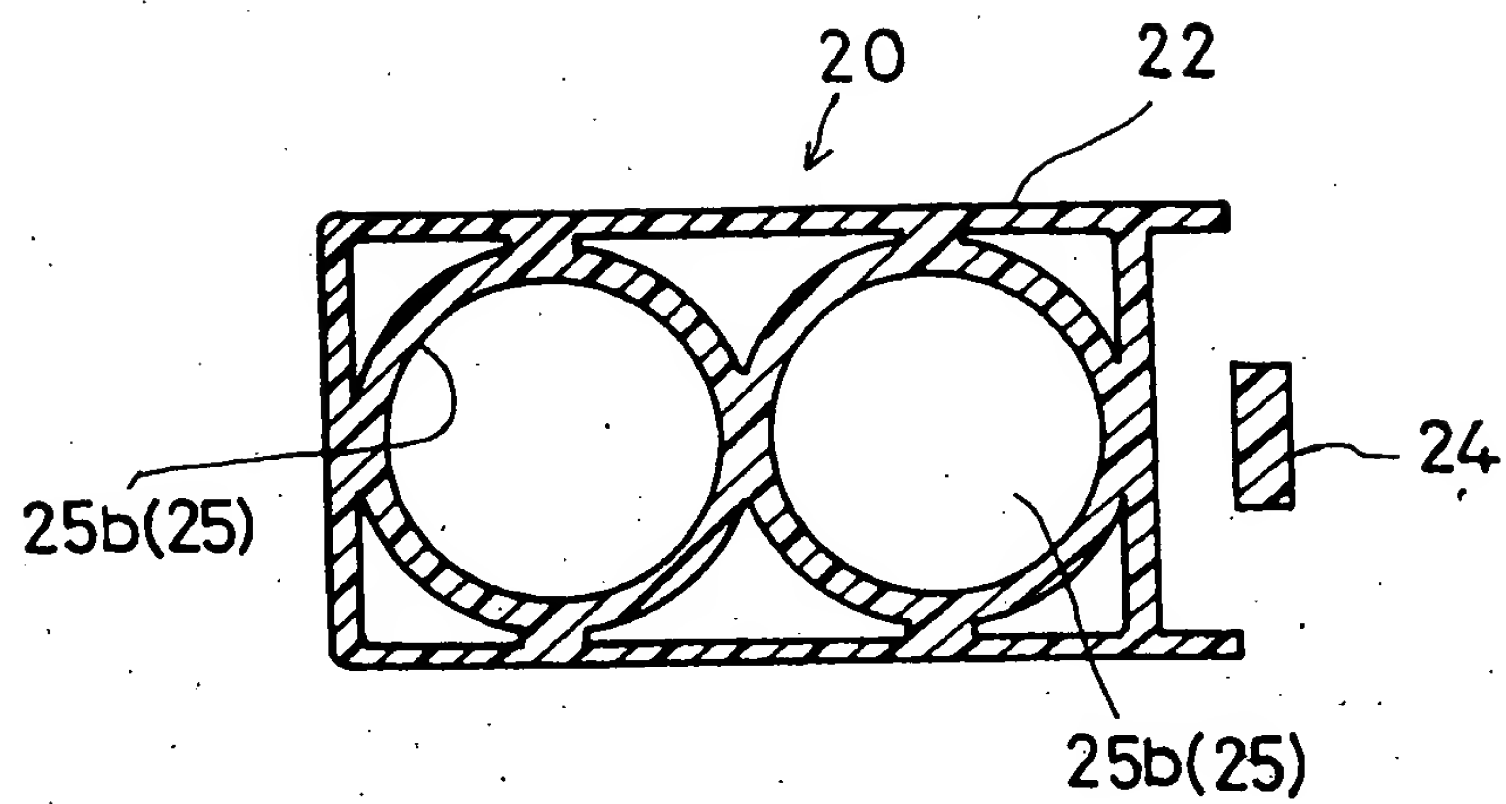


Fig. 5

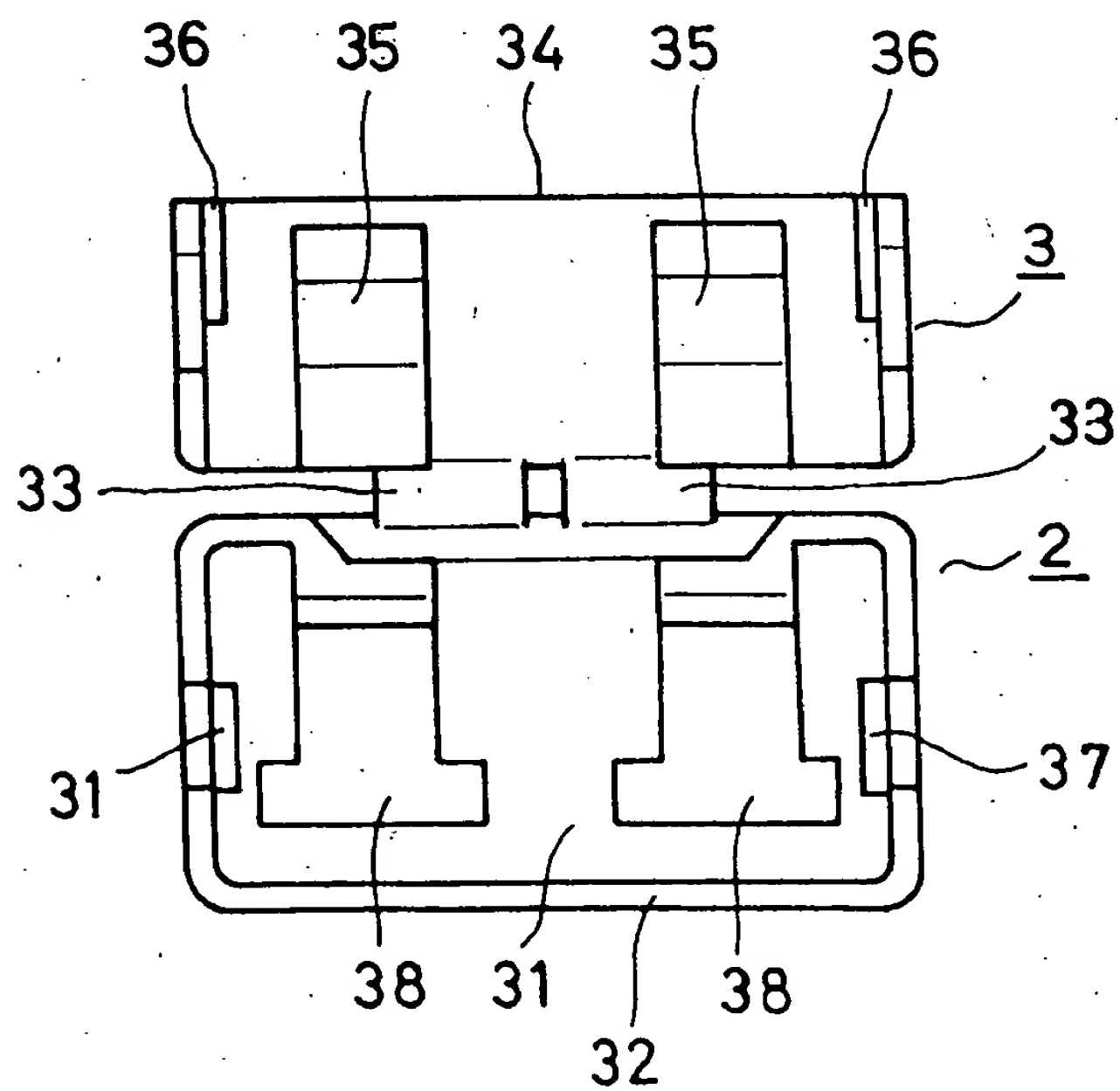


Fig. 6

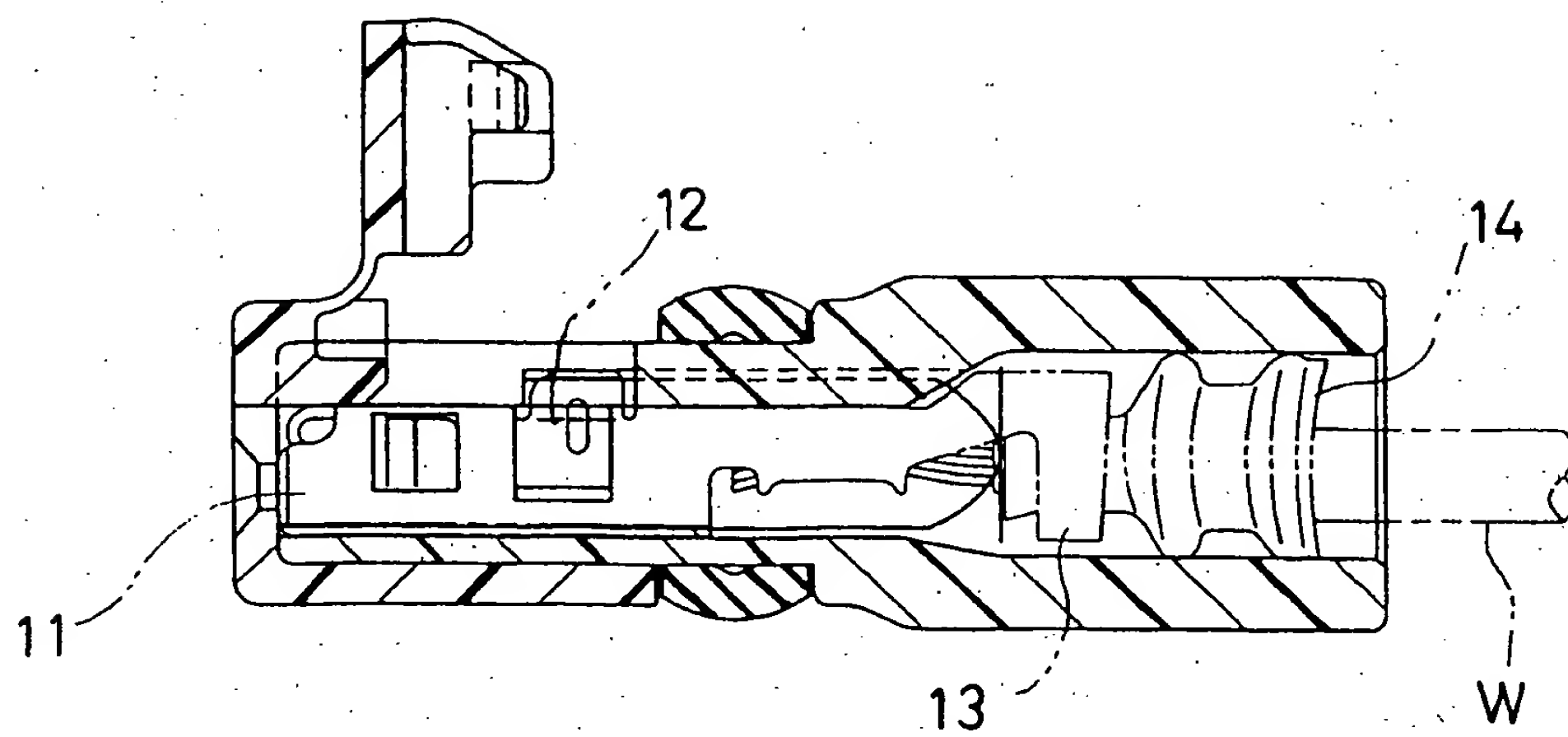


Fig. 7

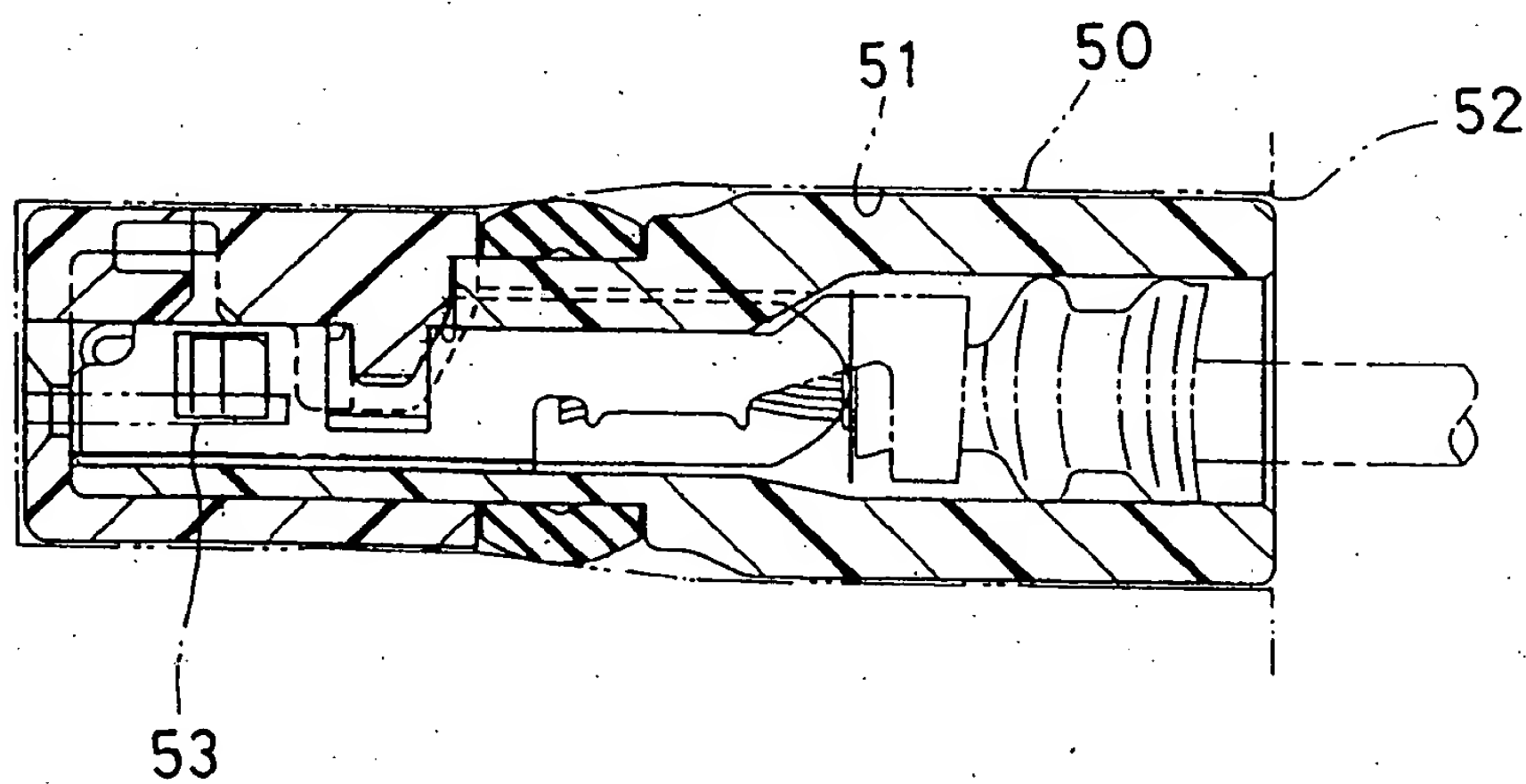


Fig. 8

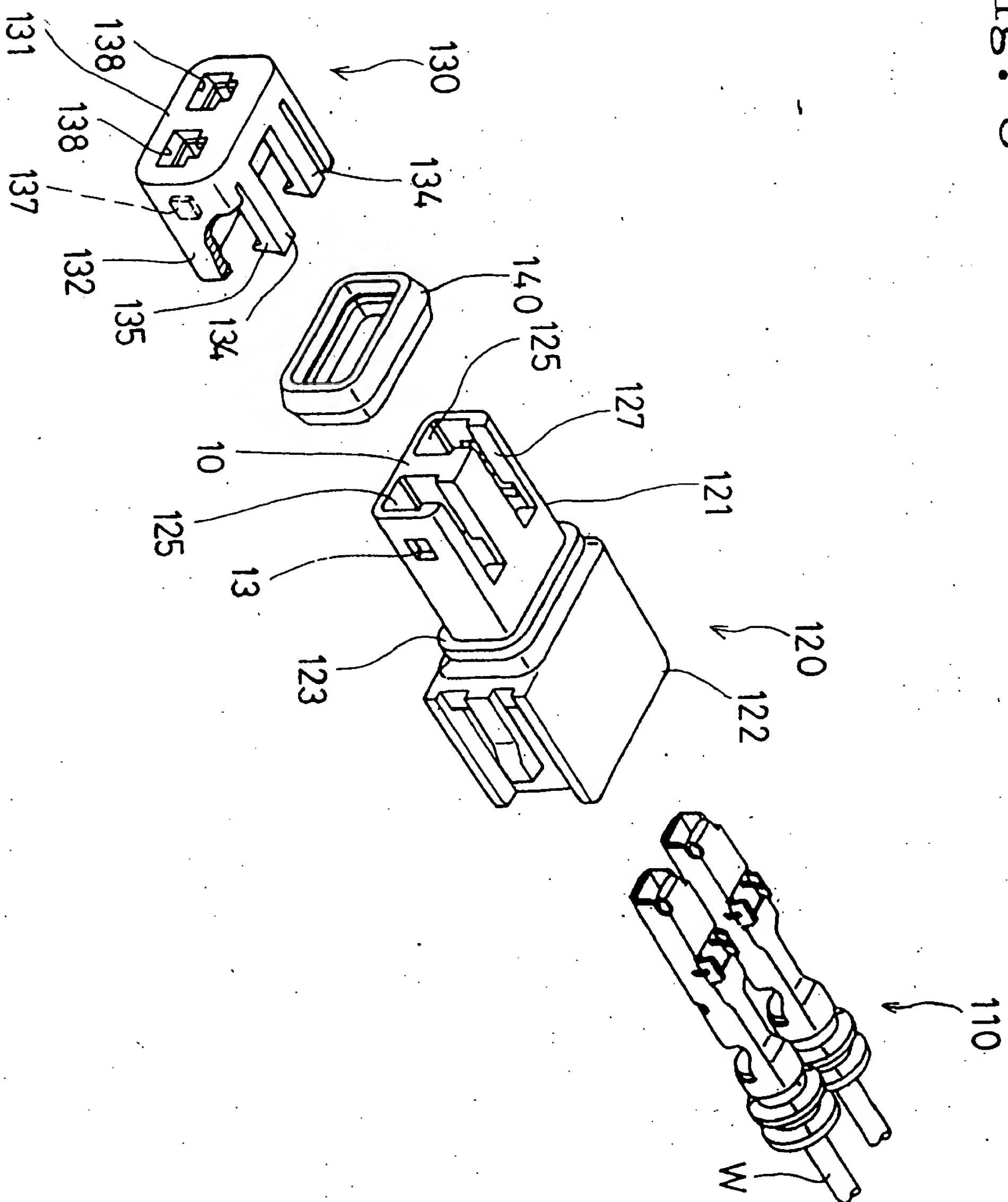


Fig. 9

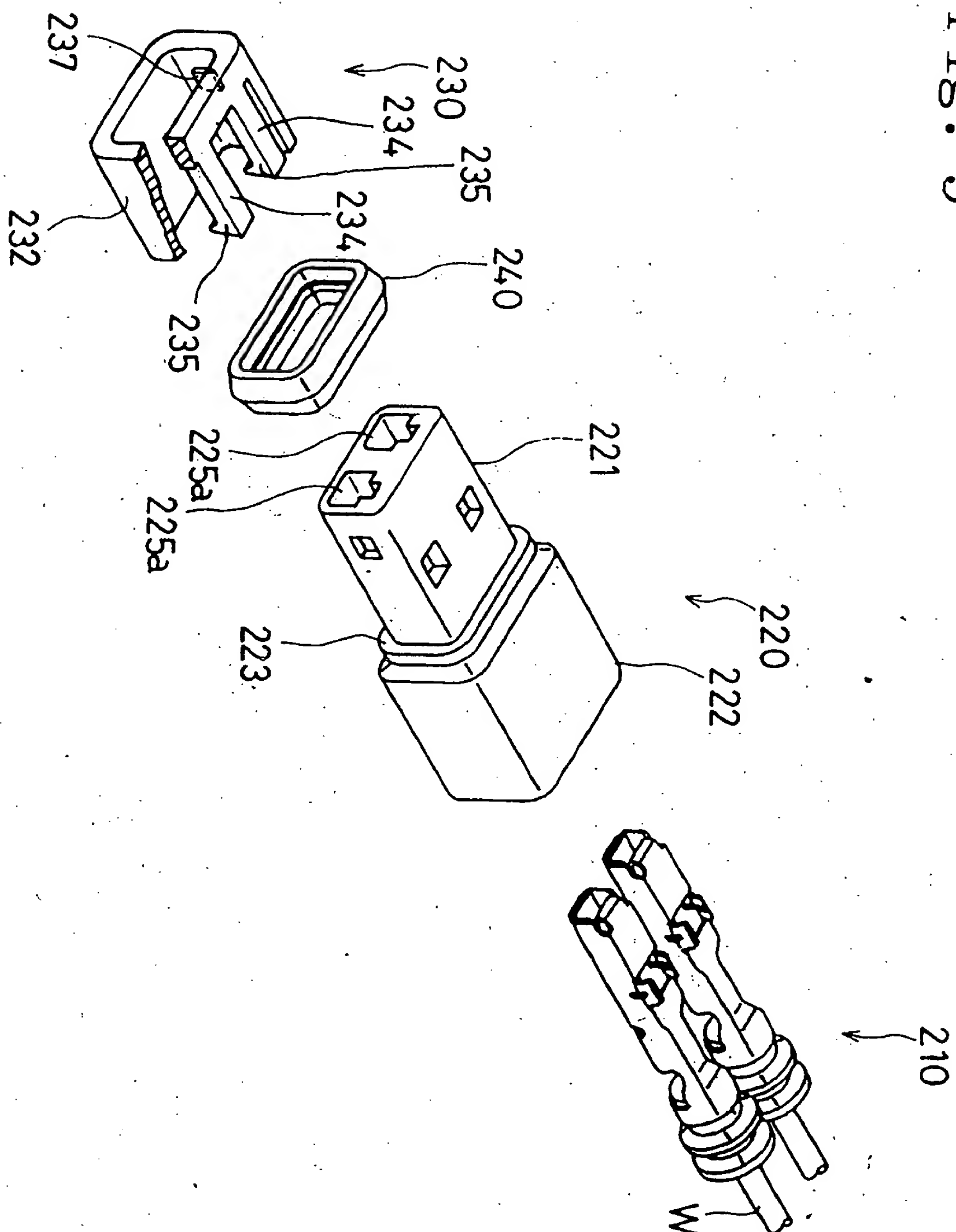
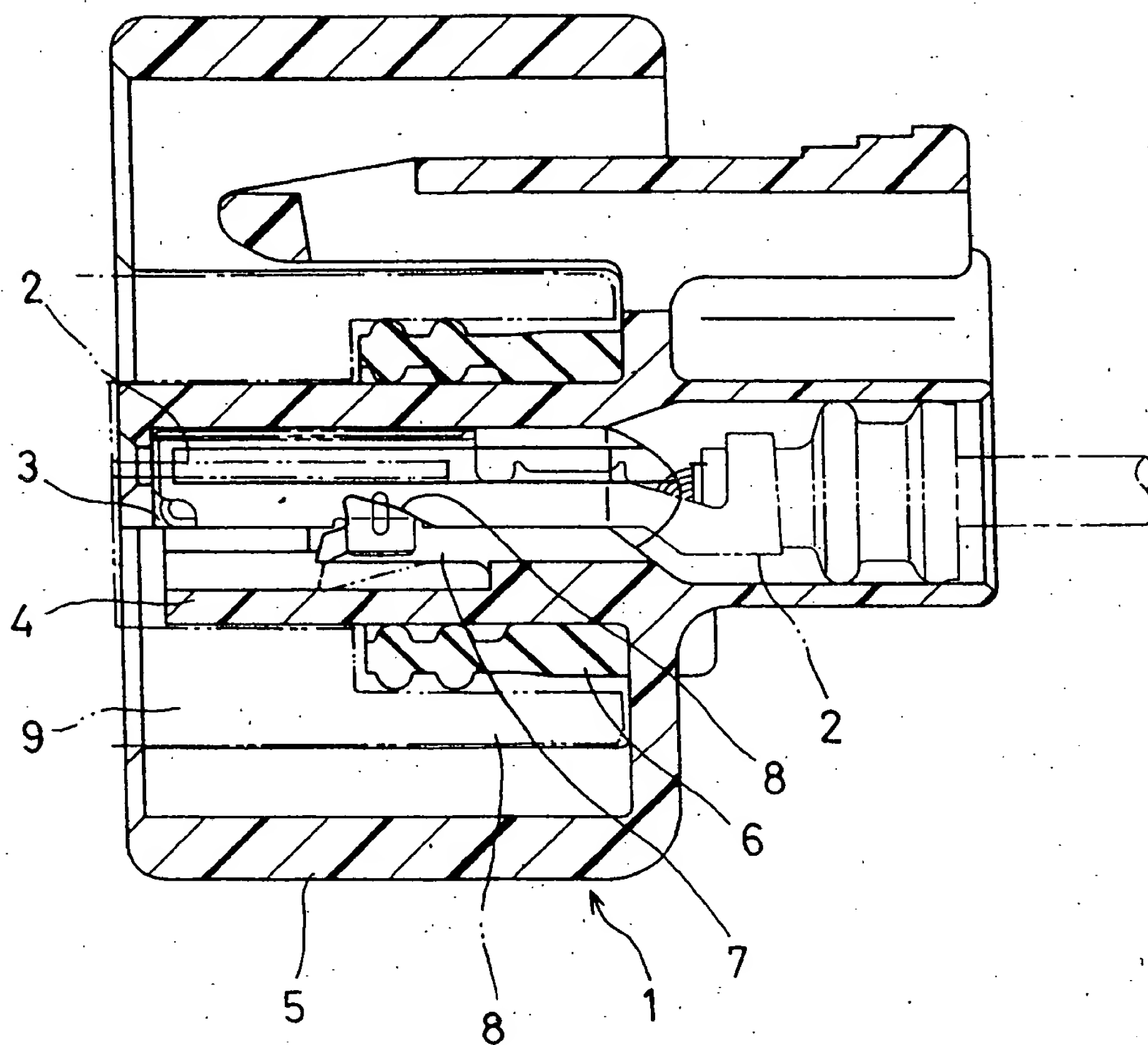


Fig. 10



Prior Art